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science for global insight

AgMIP workshop

Global and regional linkages in SSPs and RAPs

Petr Havlík, Hugo Valin, Amanda Palazzo, IIASA

In collaboration with other IAV and IAM modelling teams

Outline

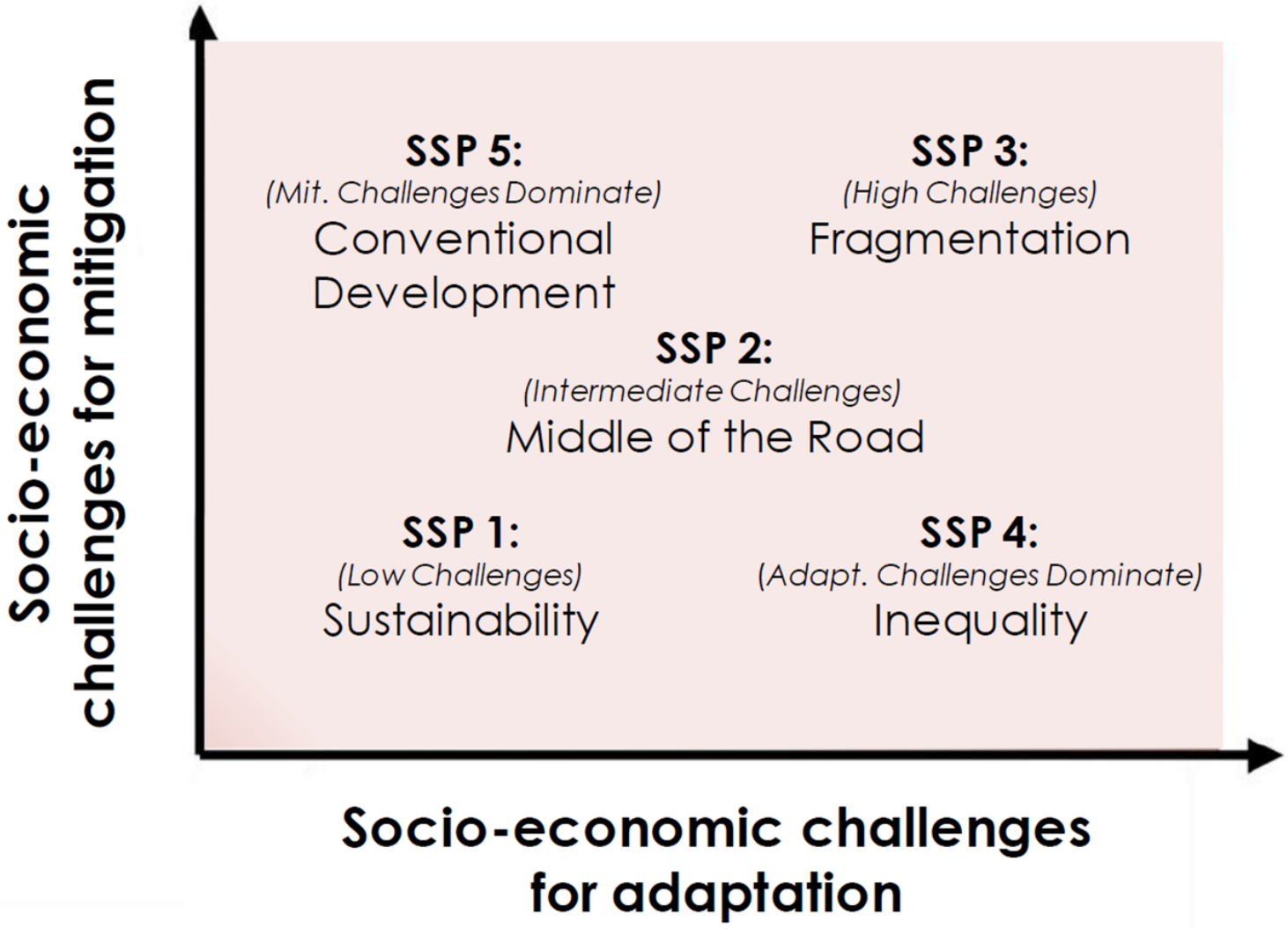
1. Global SSPs and agricultural drivers

2. From SSPs and RCPs to RAPs

3. Linking global and regional scenarios

Global SSPs and agricultural drivers

Shared Socio-economic Pathways (SSPs)



SSP Elements

- **Demographics:**

Population growth, Fertility, Mortality, Migration, Level and type of urbanization, Education

- **Economy and lifestyles:**

Growth, Structure, Inequality, International trade, Globalization, Consumption, Diets

- **Policies and institutions:**

International cooperation, Environmental policy, Institutions

- **Technology:**

Development, Transfer, Carbon intensity, Energy Intensity

- **Environment and natural resources:**

Fossil constraints, Environment, Agriculture

SSP2: Middle of the Road

General

- medium economic growth overall
- slow convergence between LIC and HIC
- **inequality remains high**
- population growth moderate – high in some LICs
- **reducing resource intensity** (slower than SSP1)
- **reducing fossil fuel dependency** (slower than SSP1)
- **uneven planned urbanization in LIC**
- world economy fragmented – **reduced flows of trade and technologies**
- **rapid technological change in HIC** but not shared with LIC

Agriculture

- **trade barriers in agricultural markets remain**

From SSPs storylines to agricultural variables

Currently quantified by five IAM/IAV modelling teams

	SSP1	SSP2	SSP3	SSP4	SSP5
	Land use is strongly regulated, e.g. tropical deforestation rates are strongly reduced. Crop yields are rapidly increasing in low- and medium-income regions, leading to a faster catching-up with high income countries. Healthy diets with low animal-calorie shares and low waste prevail. In an open, globalized economy, food is traded internationally.	Land use change is incompletely regulated, i.e. tropical deforestation continues, although at slowly declining rates over time. Rates of crop yield increase decline slowly over time, but low-income regions catch up to a certain extent. Caloric consumption and animal calorie shares converge towards medium levels. International trade remains to large extent regionalised.	Land use change is hardly regulated, i.e. tropical deforestation continues at current rates. Rates of crop yield increase decline strongly over time, due to little investment. Unhealthy diets with high animal shares and high waste prevail. A regionalized world leads to reduced trade flows.	Land use change is strongly regulated in high income countries, but tropical deforestation still occurs in poor countries. High income countries achieve high crop yield increases, while low income countries remain relatively unproductive in agriculture. Caloric consumption and animal calorie shares converge towards medium levels. Food trade is globalized, but access to markets is limited in poor countries, increasing vulnerability for non-connected population groups.	Land use change is incompletely regulated, i.e. tropical deforestation continues, although at slowly declining rates over time. Crop yields are rapidly increasing. Unhealthy diets with high animal shares and high waste prevail. Barriers to international trade are strongly reduced, and strong globalization leads to high levels of international trade.
Country income grouping	low medium high	low medium high	low medium high	low medium high	low medium high
Land-use change regulation	strong	medium	weak	weak medium strong	medium
Land productivity growth	rapid rapid medium	medium	slow	slow medium rapid	rapid
Environmental Impact of food consumption	low	medium	high	medium	high
International trade	globalized	regionalized	regionalized	limited access globalized globalized	globalized

Demand

Markets

Production

Land use

Land cover

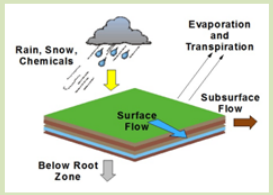
Population, GDP, consumer preferences

Food | Fibers | Energy | Industry

MARKET & TRADE: EU + WORLD → **PRICES**

FEED | FEEDSTOCK | FEED | BIOMASS

EPIC
Crop model



RUMINANT
Digestibility model

→ Feed intake
→ Animal production
→ GHG emissions

BIOENERGY
Processing

→ MJ biofuel
→ MJ bioelectric
→ Coproducts

G4M
Global Forest model

→ Harvestable wood
→ Harvesting costs

Worldwide:
18 crops (FAO + SPAM)
Management systems:
low/high input & irrigated

EU28:
9 additional crops,
crop rotations.
Management options:
fertilizer, irrigation & tillage

7 animals
(FAO + Gridded livestock)

Cattle & Buffalo
Sheep & Goat
Pig
Poultry

8 different systems

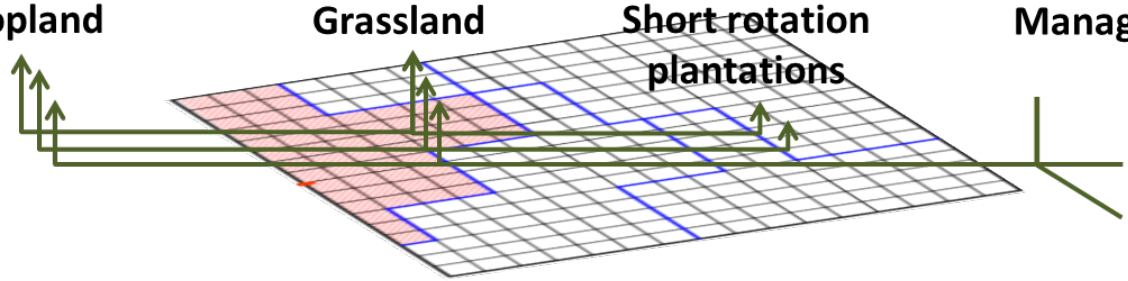
Perennial crops
Short rotation coppice

Conversion technologies
First generation biofuels
Second generation biofuels
Biomass power plants

Downscaled FAO FRA at grid level

Area
Carbon stock
Age
Tree size
Species
Rotation time
Thinning

Cropland | **Grassland** | **Short rotation plantations** | **Managed forest**

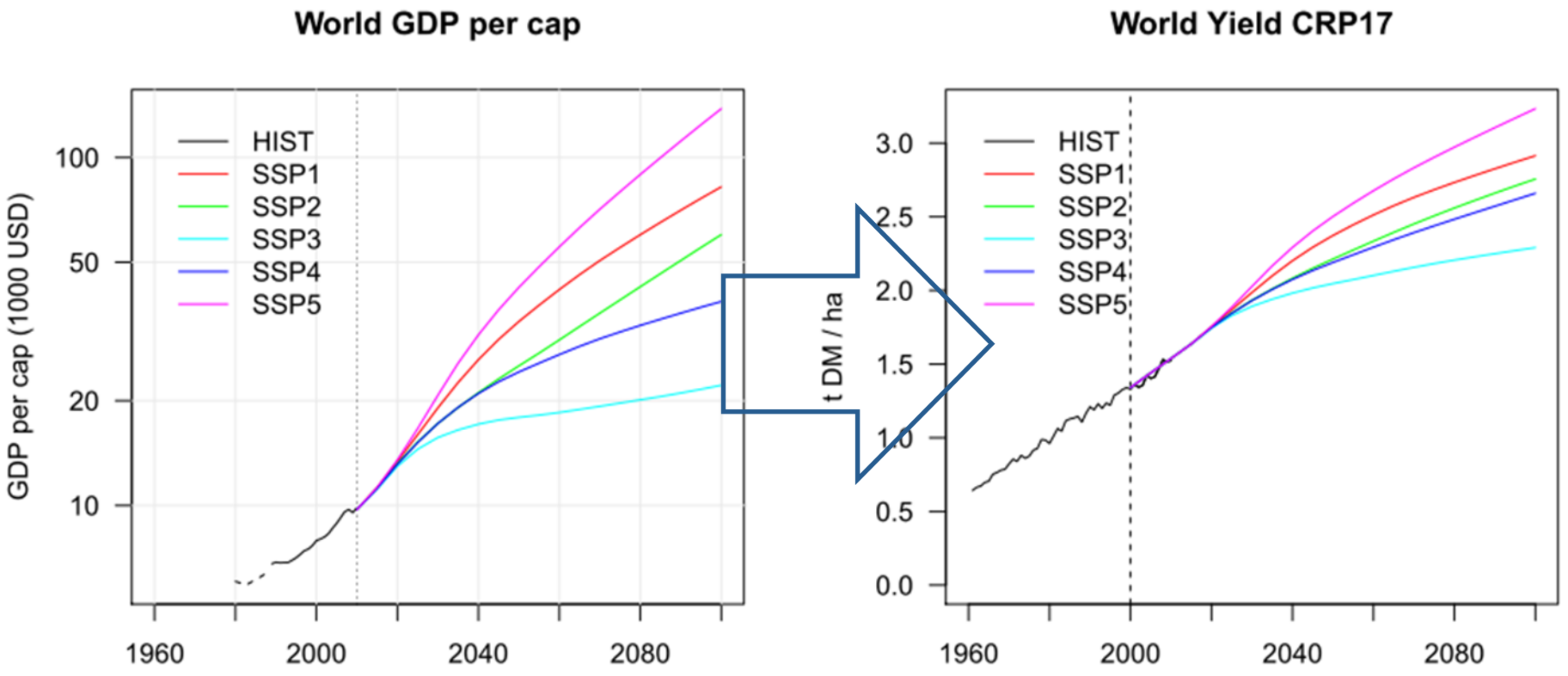


Natural forest

Other natural land

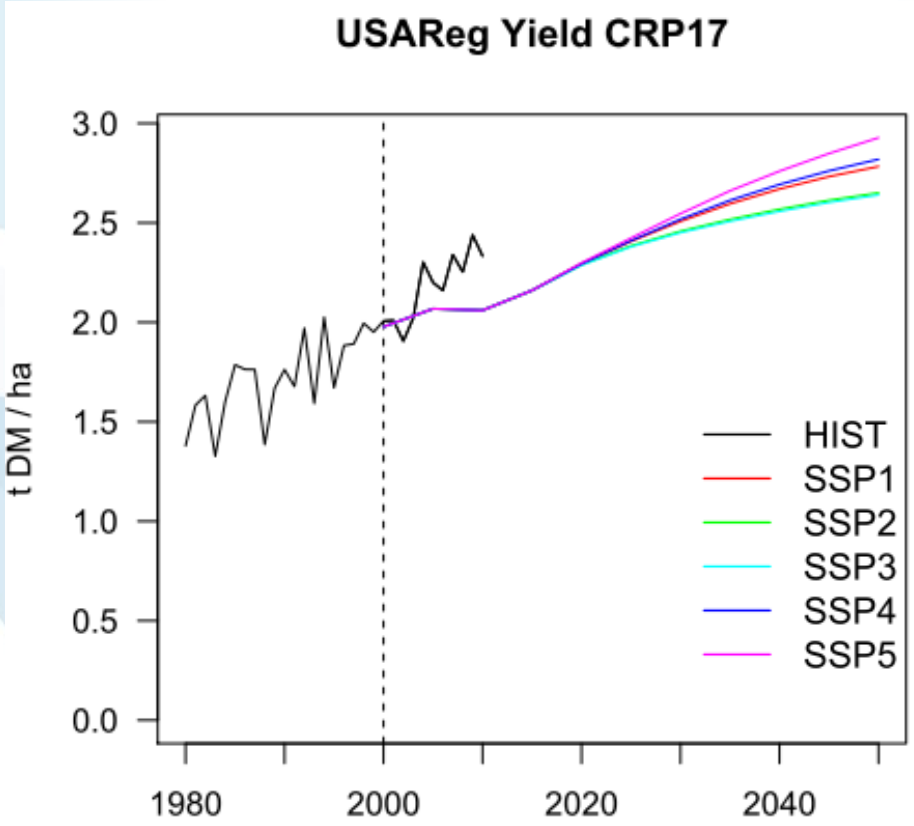
Gridded representation of world land use

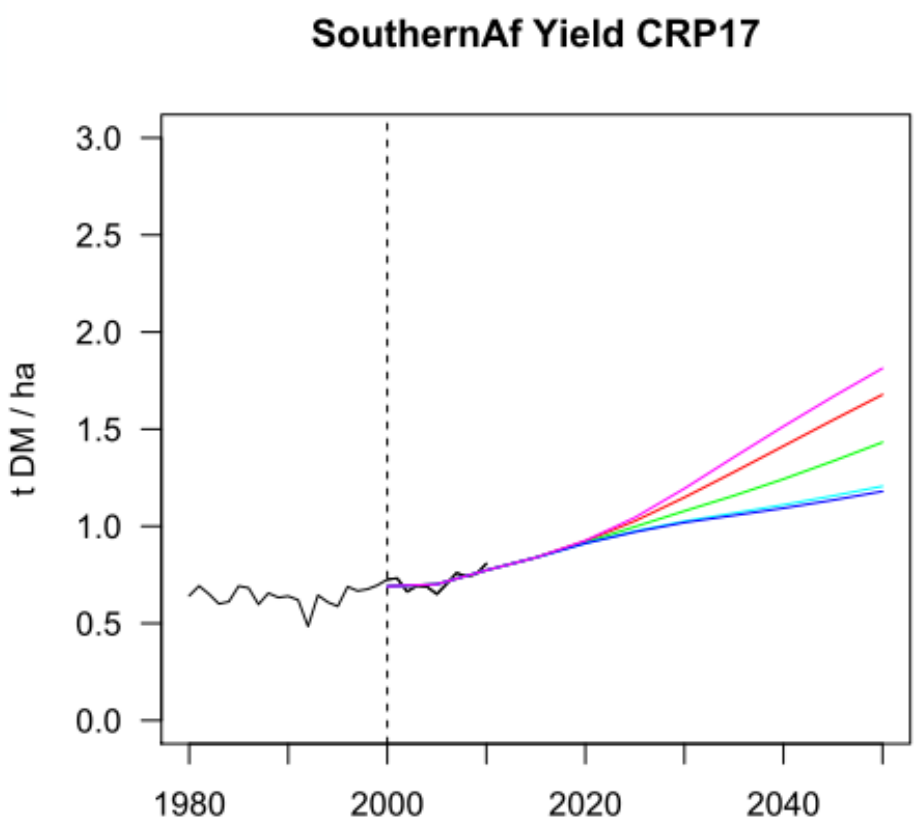
Crop yield development in GLOBIOM



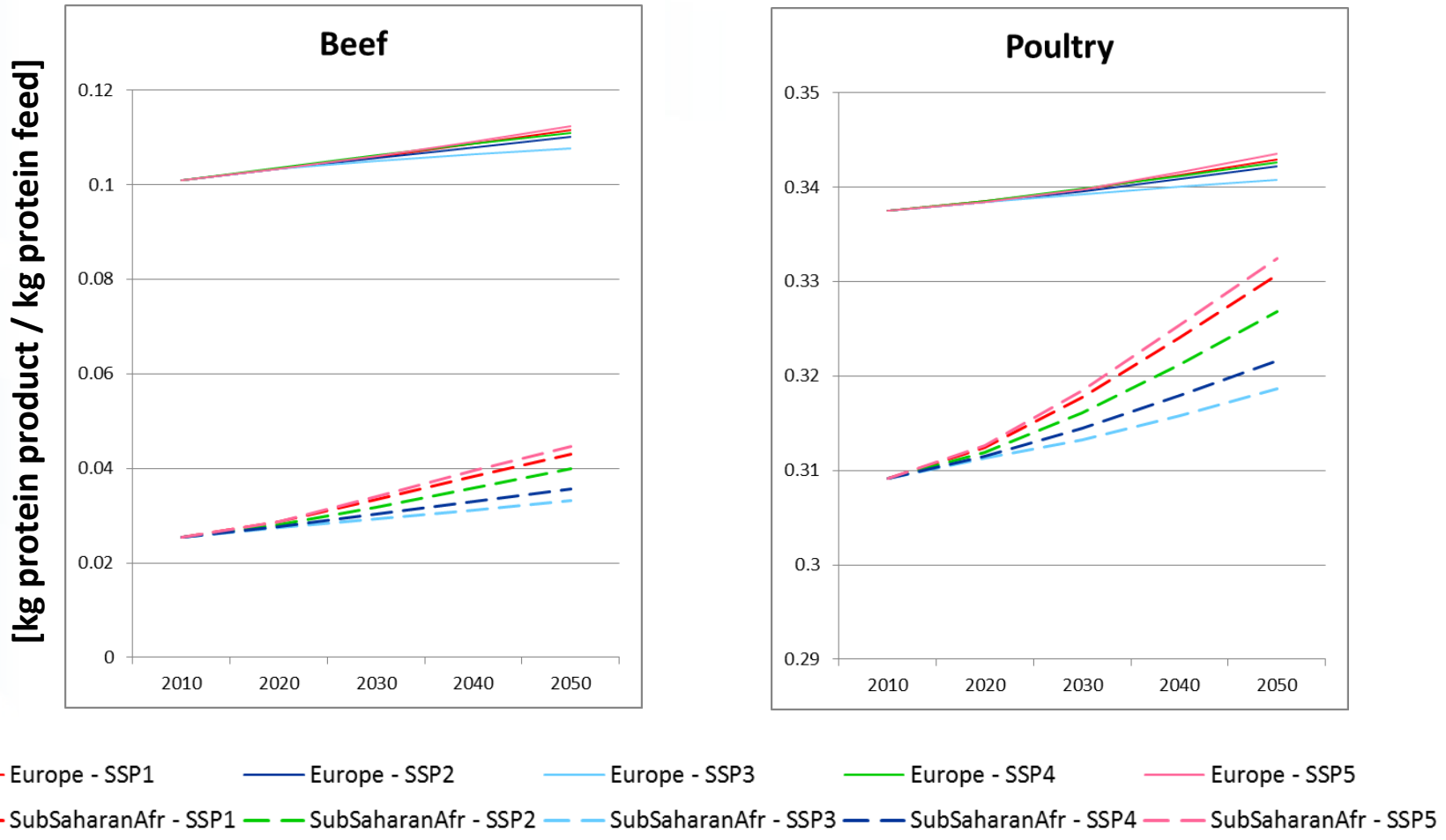
Crop yield developments projected as a function of GDP per capita
based on econometric estimation on 1980-2010, and 4 income group clusters.

Crop yield development in GLOBIOM

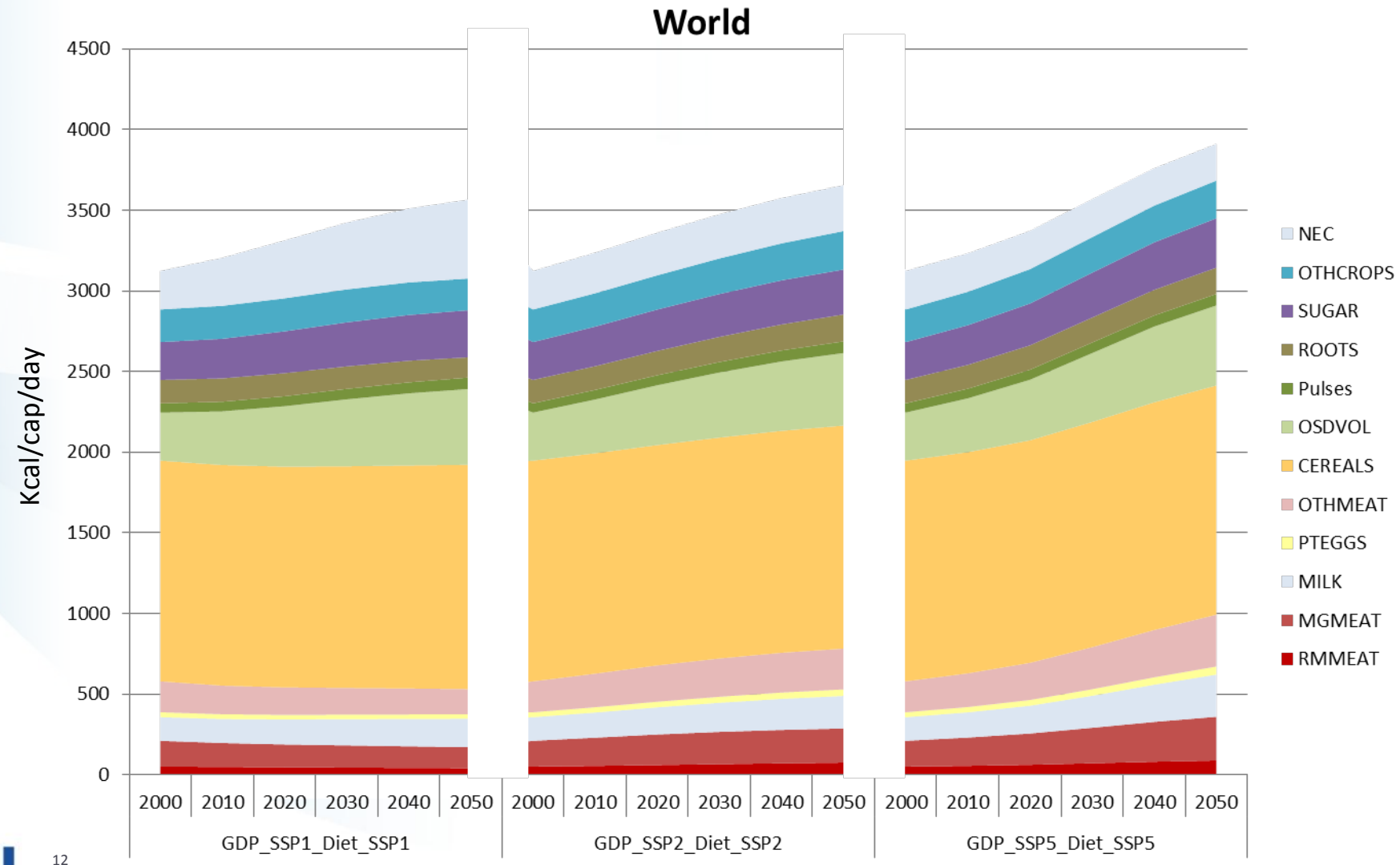




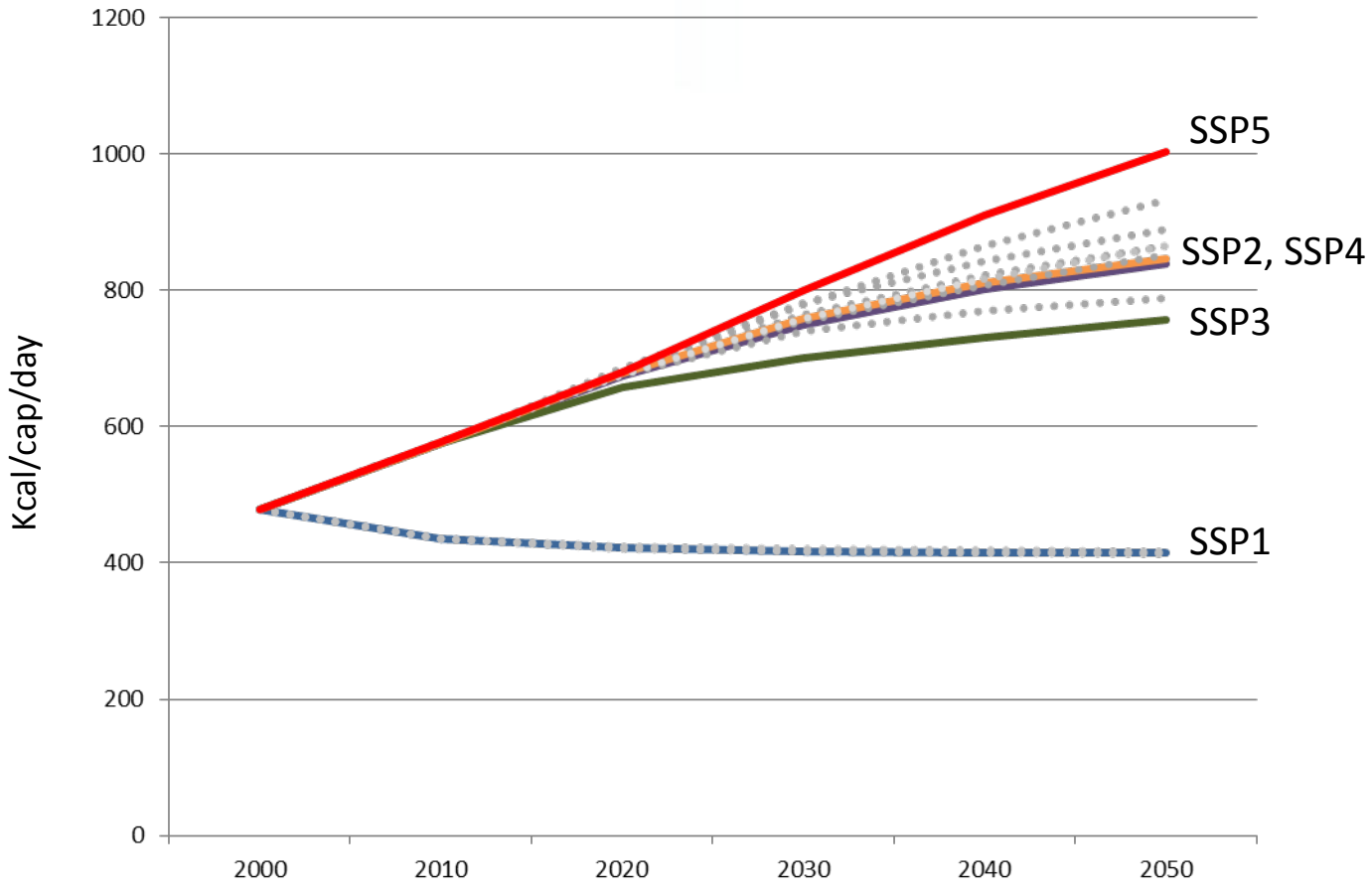
Feed conversion efficiencies across SSPs



Quantification of diet preferences



China – Animal products food consumption



Losses and wastes across the supply chain

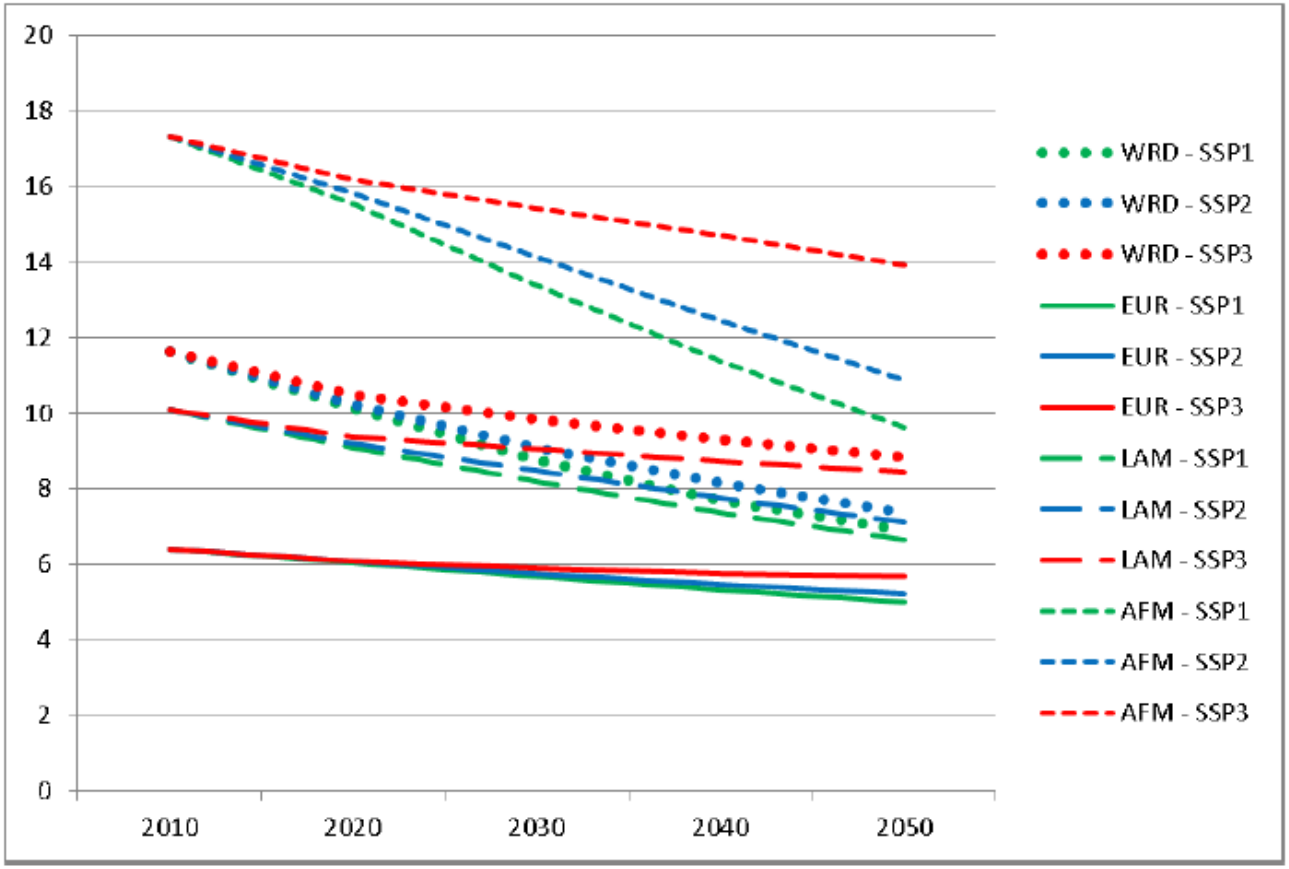


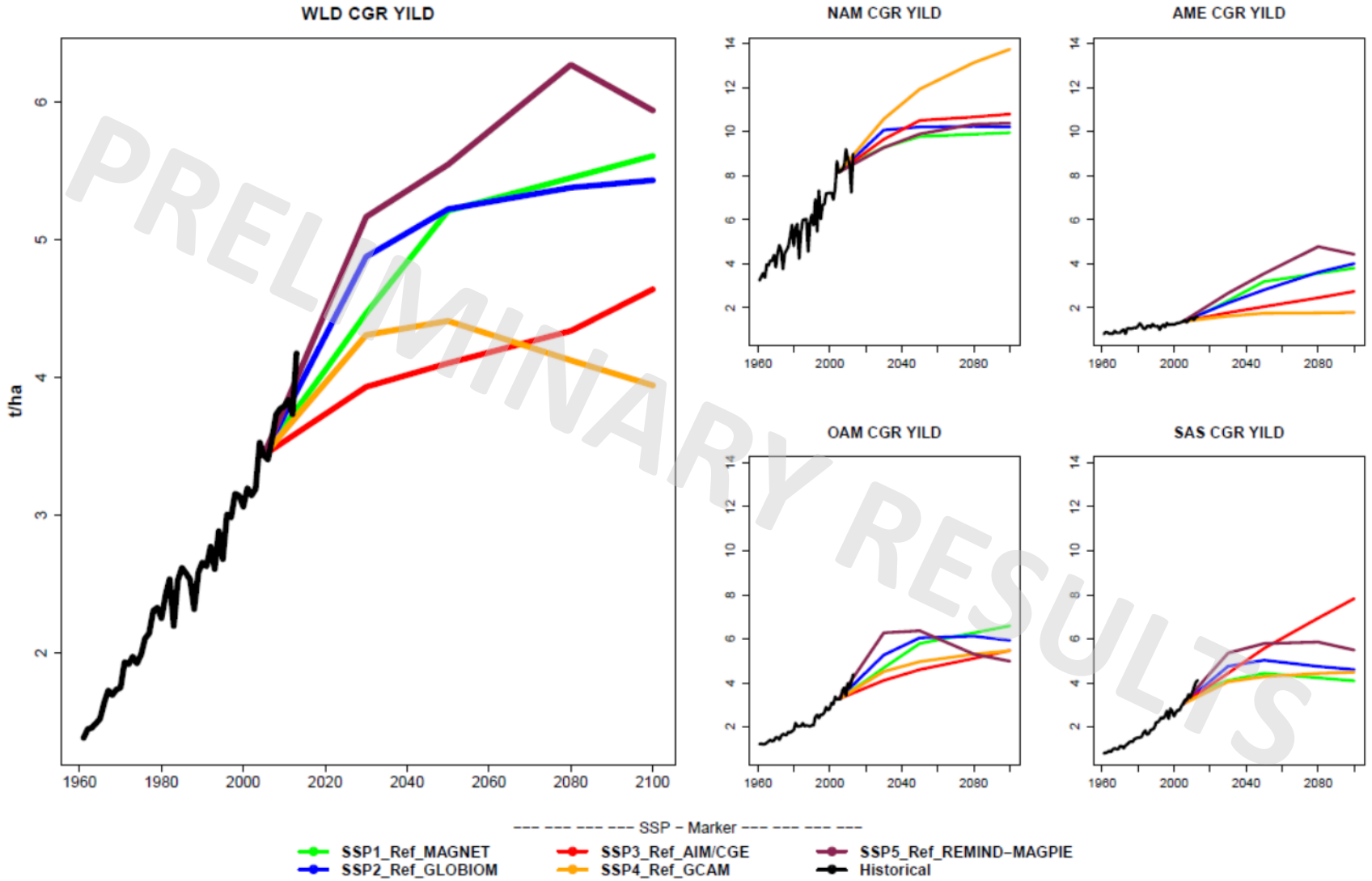
Figure 8: Losses and wastes development in the Oilseeds&Pulses sector [%].

IAM & IAV Modelling intersection

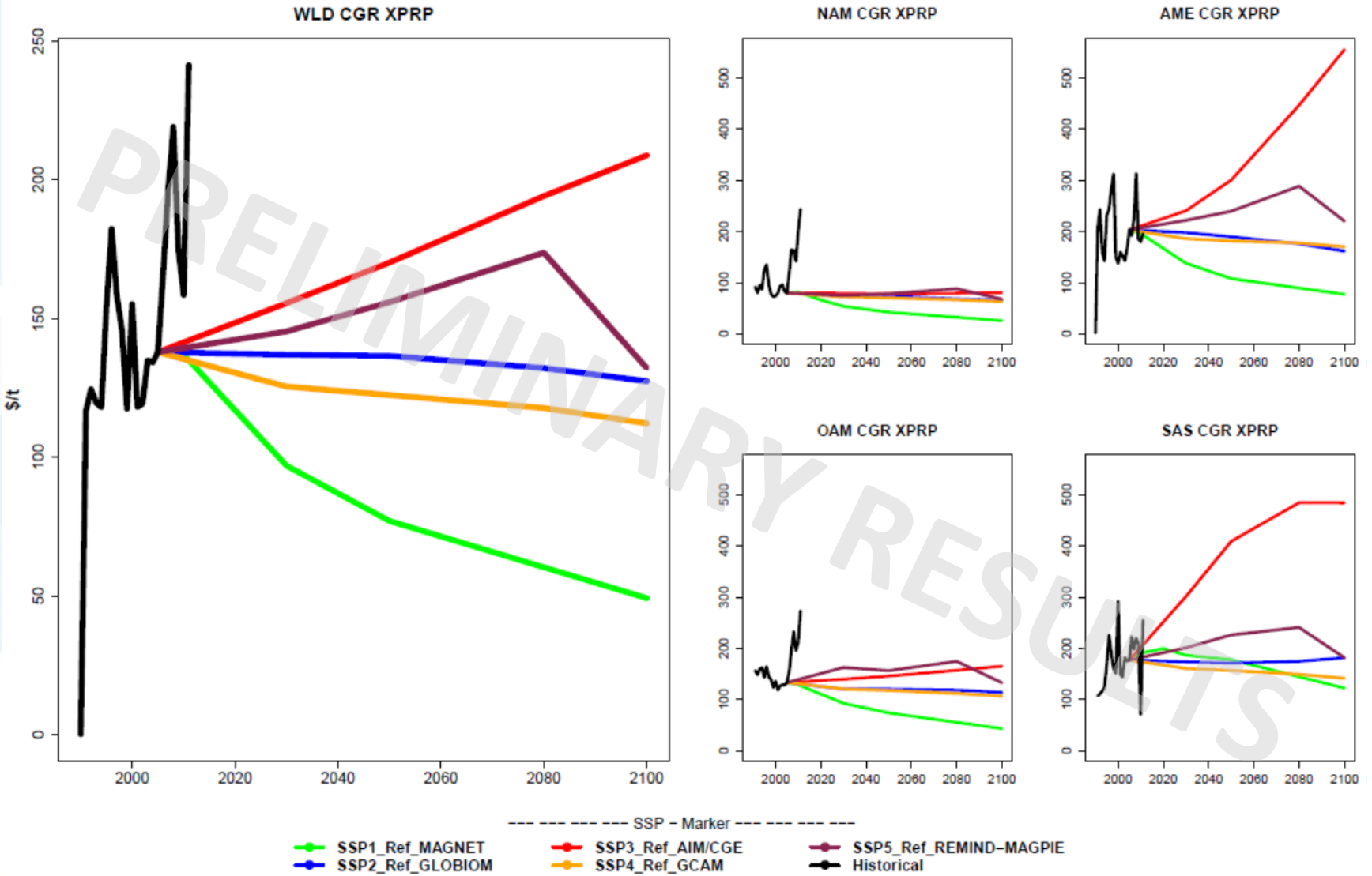
- Five models out of ten in AgMIP Phase 1 are part of IAM modelling comparison

- SSPs markers
  - SSP1: MAGNET-IMAGE
  - SSP2: GLOBIOM-MESSAGE
  - SSP3: AIM\CGE
  - SSP4: GCAM
  - SSP5: MagPIE-REMIND

SSPs Markers: Yield

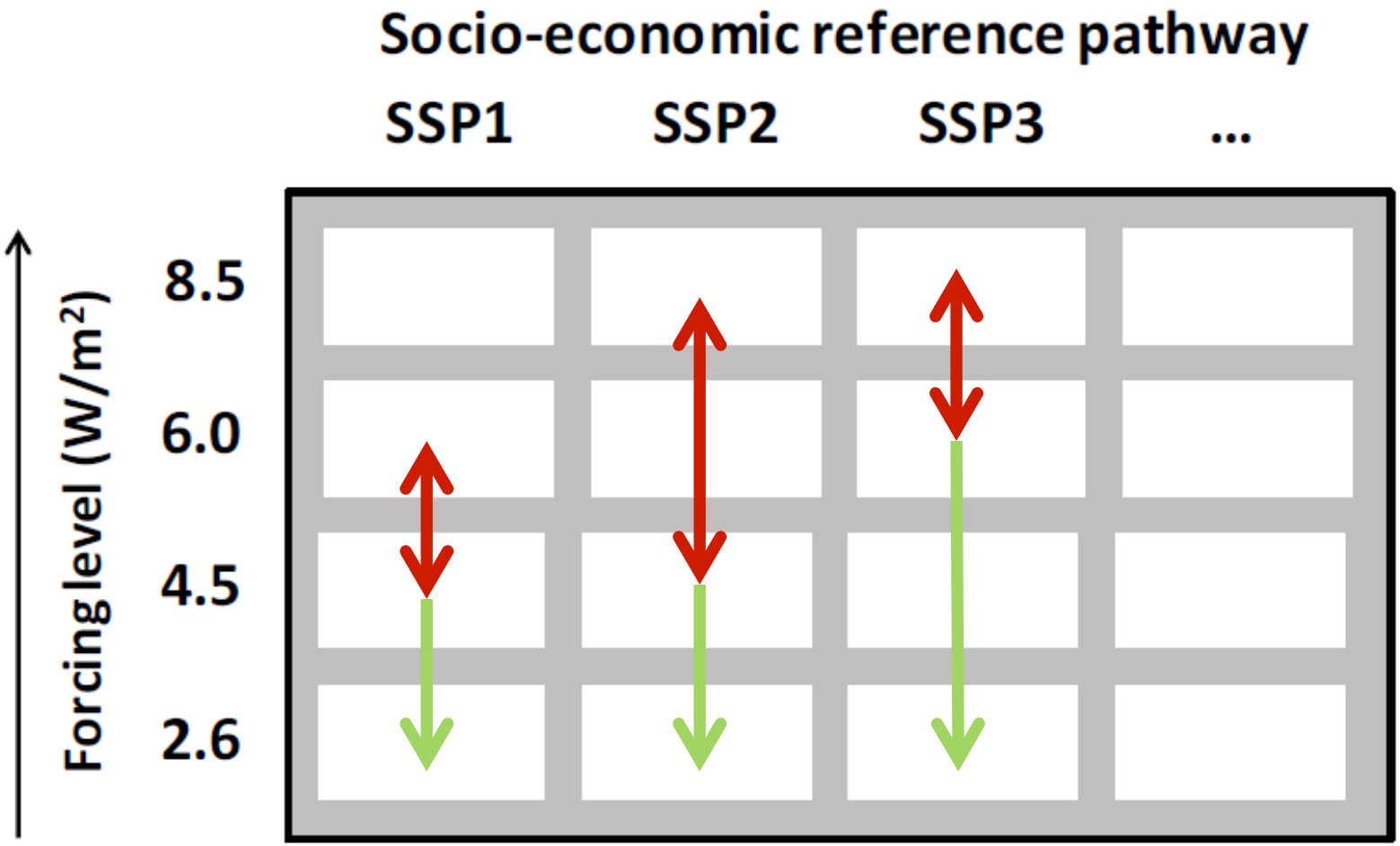


SSPs Markers: Prices



From SSPs and RCPs to RAPs…

SSP-RCP scenarios matrix approach



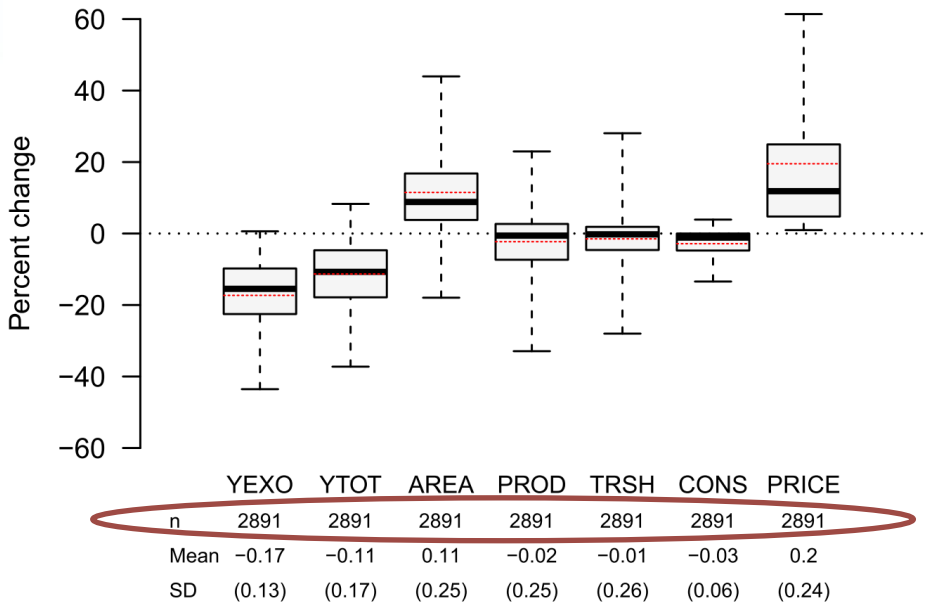
Reference scenarios

Stabilization scenarios

Challenge of multi-dimensionality

- AgMIP Phase 1
  - 1 RCP (RCP8.5)
  - 5 GGCMs and 2 GCMs → 7 scenarios
    - 2 with 2 GCMs
    - 3 with 1 GCMs
  - 1 scenario on management and CO_2 effects (no effect)
  - 1 SSP (SSP2)
  - 4 crop aggregates (wheat, rice, coarse grain, oilseeds)

  X
  - 9 global economic models
  - 13 economic regions



	YEXO	YTOT	AREA	PROD	TRSH	CONS	PRICE
n	2891	2891	2891	2891	2891	2891	2891
Mean	−0.17	−0.11	0.11	−0.02	−0.01	−0.03	0.2
SD	(0.13)	(0.17)	(0.25)	(0.25)	(0.26)	(0.06)	(0.24)

Source: Nelson et al., PNAS (2013)

Challenge of multi-dimensionality

- AgMIP Phase 1
  - 1 RCP (RCP8.5)
  - 5 GGCMs and 2 GCMs → 7 scenarios
    - 2 with 2 GCMs
    - 3 with 1 GCMs
  - 1 scenario on management and CO_2 effects (no effect)
  - 1 SSP (SSP2)
  - 4 crop aggregates (wheat, rice, coarse grain, oilseeds)

  X
  - 9 global economic models
  - 13 economic regions

- AgMIP Phase 2?
  - 4 RCPs
  - n GGCMs and m GCMs → xx scenarios
  - x management settings
  - 2 scenarios on CO_2 effects
  - 5 SSPs (SSP2)
  - n crops
  - **RAPs?**

  X
  - 15? global economic models
  - 13? economic regions

Challenge of multi-dimensionality

- AgMIP Phase 1
  - 1 RCP (RCP8.5)
  - 5 GGCMs and 2 GCMs → 7 scenarios
    - 2 with 2 GCMs
    - 3 with 1 GCMs
  - 1 scenario on management and CO_2 effects (no effect)
  - 1 SSP (SSP2)
  - 4 crop aggregates (wheat, rice, coarse grain, oilseeds)

  X
  - 9 global economic models
  - 13 economic regions

- IIASA contribution
  - 4 RCP (RCP8.5)
  - 1 GGCMs (EPIC)
  - 5 GCMs
  - 3 management settings
    - Low input
    - High input
    - High input irrigated
  - 2 scenarios on CO_2 effects (for 1 GCM)
  - 5 SSPs
  - 17 crops (incl. cassava!)

  X
  - 1 economic model (GLOBIOM)
  - 30 economic regions
- See Leclère et al. (2014)

SSPs and RPCs into RAPs

- AgMIP phase 2: draft protocol Global Economic team

Climate	SSP1	SSP2	SSP3	SSP4	SSP5
RCP8.5	X	X	X	X	RAP5
RCP6.0	RAP1	RAP2	RAP3	RAP4	
RCP4.5			RAP3m		
RCP2.6	RAP1m	RAP2m	X	RAP4m	RAP5m
NoCC	RAP1noCC	RAP2noCC	RAP3noCC	RAP4noCC	RAP5noCC5

Reference scenario

Mitigation scenarios

Pure SSPs

X – These combination are not feasible in current IAM runs, but may still be run in complementary scenarios

Already a first set of runs for EU models

- AGCLIM50 projects with JRC: focus on RAPs for SSP1-SSP3

Climate	SSP1	SSP2	SSP3	SSP4	SSP5
RCP8.5	X	X	X	X	RAP5
RCP6.0	RAP1	RAP2	RAP3	RAP4	
RCP4.5			RAP3m		
RCP2.6	RAP1m	RAP2m	X	RAP4m	RAP5m
NoCC	RAP1noCC	RAP2noCC	RAP3noCC	RAP4noCC	RAP5noCC5

Reference scenario

Mitigation scenarios

Pure SSPs

X – These combination are not feasible in current IAM runs, but may still be run in complementary scenarios

Already a first set of runs for EU models (AGCLIM50 project)

- AGCLIM50 projects with JRC: focus on RAPs for SSP1-SSP3 **+ adaptation scenarios**

Climate	SSP1	SSP2	SSP3	SSP4	SSP5
RCP8.5	X	X	X	X	RAP5
RCP6.0	RAP1	RAP2	RAP3	RAP4	
RCP4.5			RAP3m RCP3m+a		
RCP2.6	RAP1m RAP1m+a	RAP2m RAP2m+a	X	RAP4m	RAP5m
NoCC	RAP1noCC	RAP2noCC	RAP3noCC	RAP4noCC	RAP5noCC5

Reference scenario

Mitigation scenarios

Mitigation + adaptation scenario

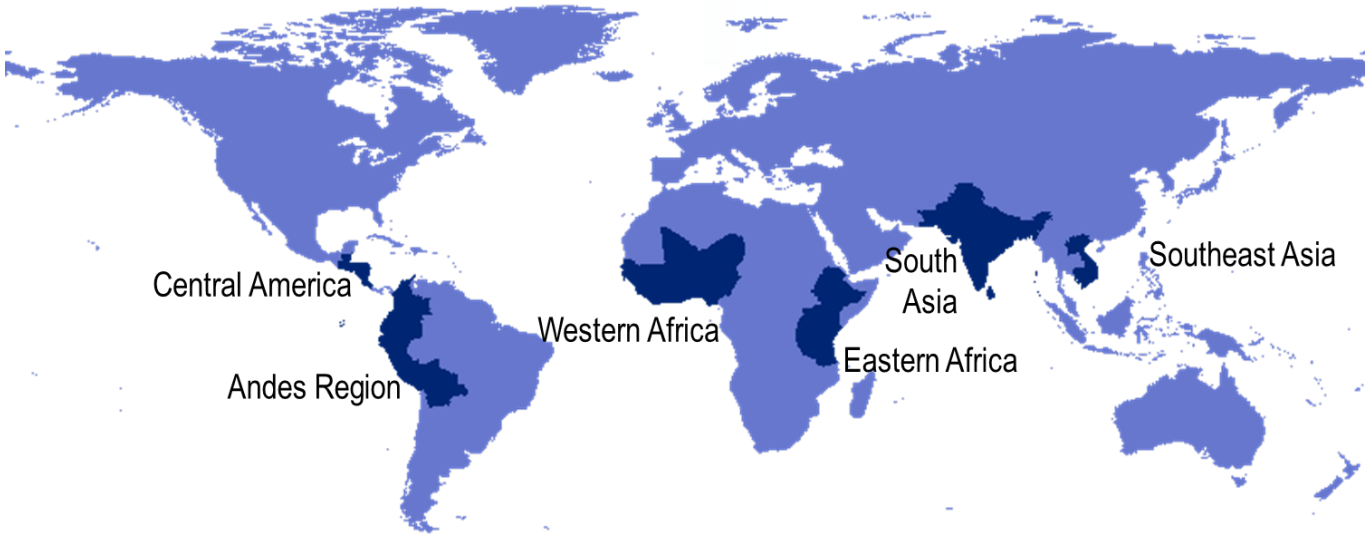
Pure SSPs

X – These combination are not feasible in current IAM runs, but may still be run in complementary scenarios

Linking global and regional scenarios

Several types of approaches

- Regional scenario set-up for global runs with focus on regional outcomes
  - CCAFS scenarios in 6 different regions with stakeholder involvement



- Regional model version at high resolution with explicit modelling of spatial markets and policies
  - Brazil
  - Congo Basin
  - Ethiopia
  - EU28

Scenario designs based on stakeholder workshops

- Identifying challenges for food security, rural livelihoods and environment

Clustering drivers

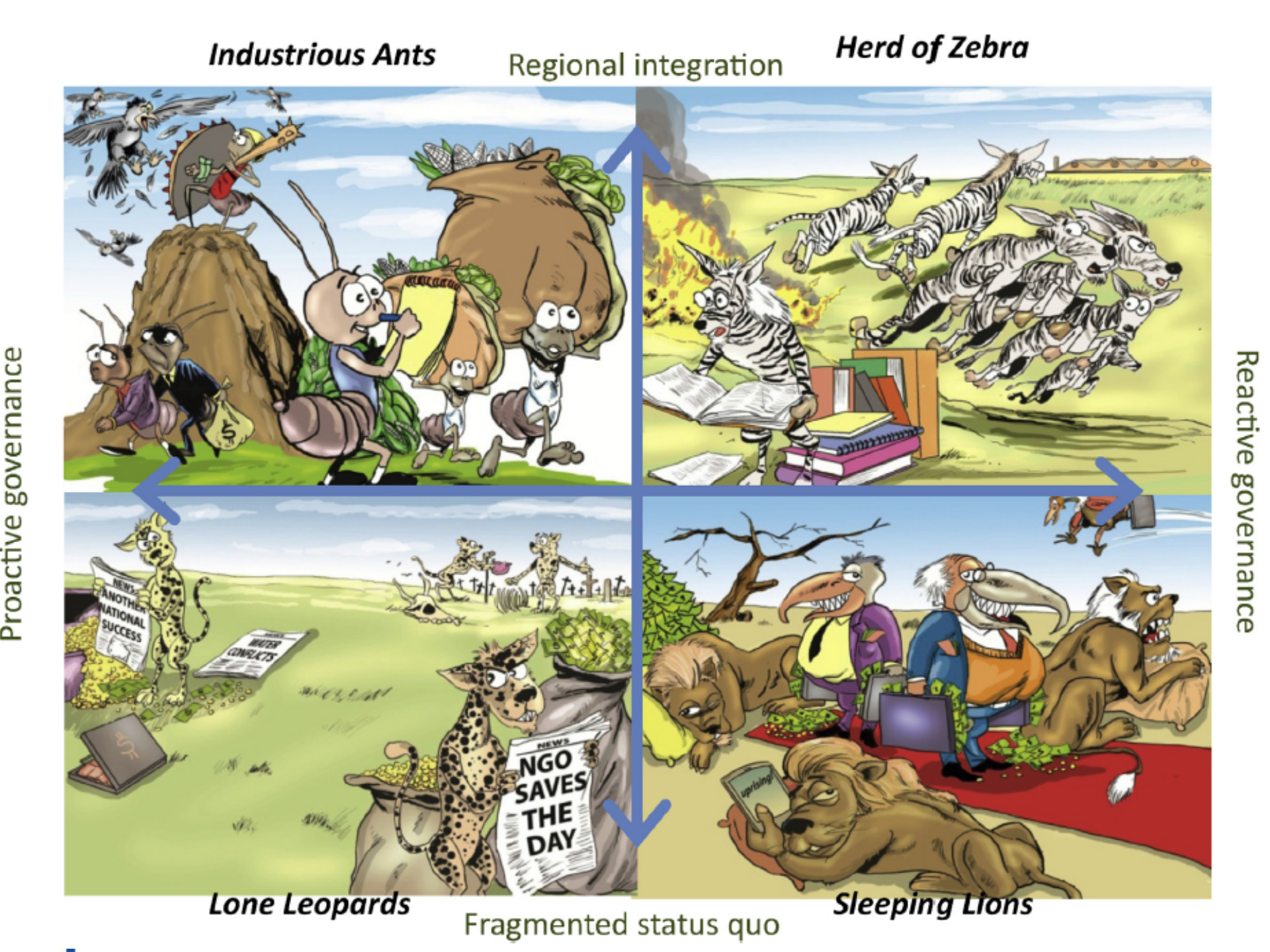
Double axes approaches

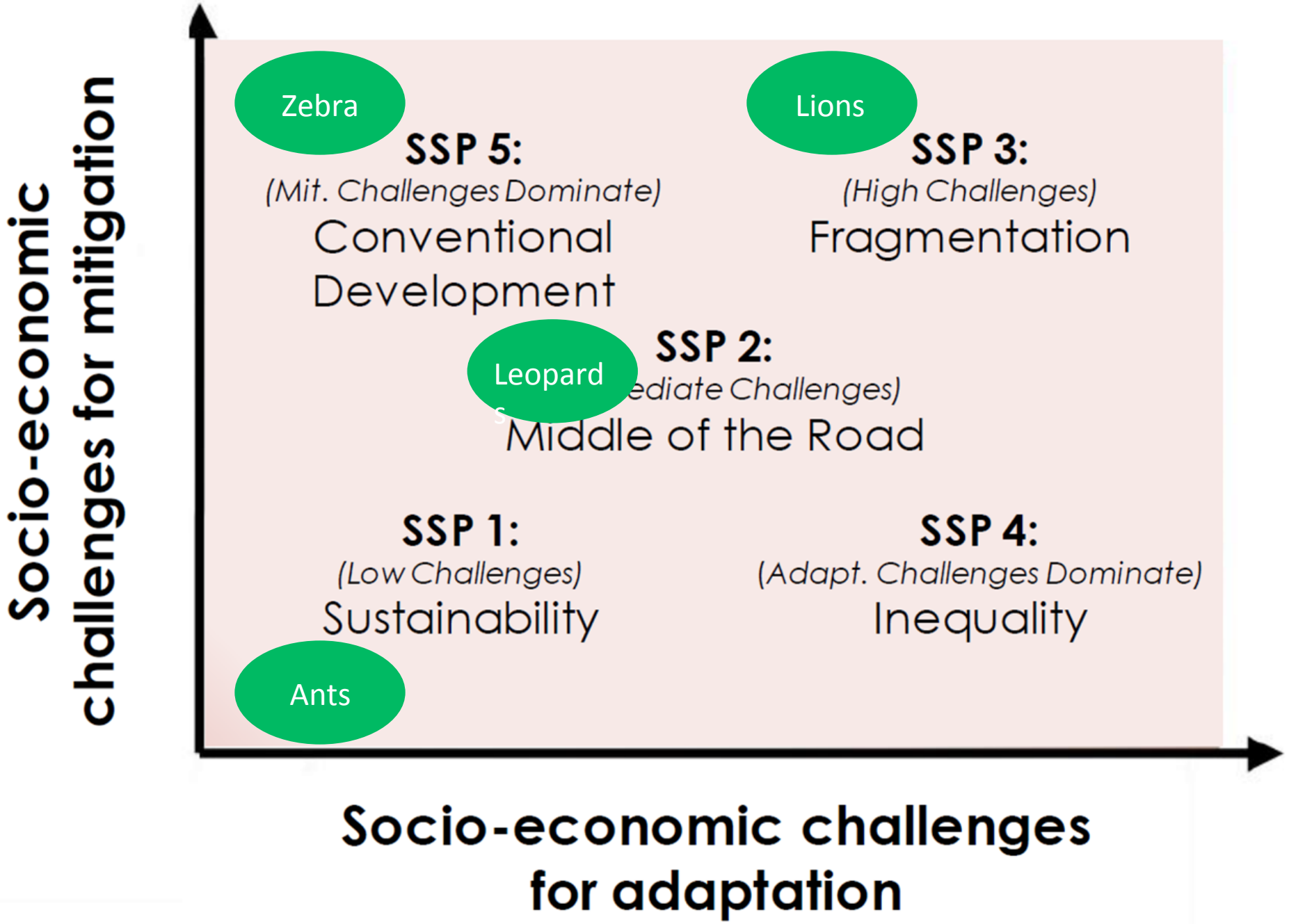
Developing narratives

Semi-quantitative drivers

Example: Eastern Africa Scenarios

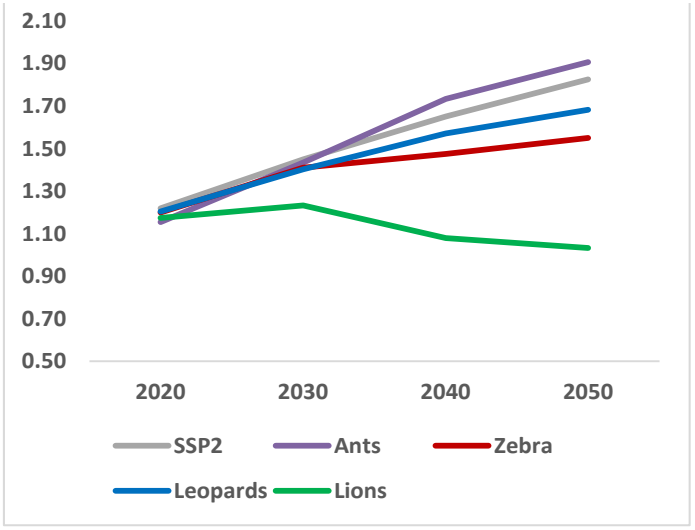
	Mode of Governance	Regional Integration
Industrious Ants	Proactive government	Regionally integrated
Herd of Zebra	Reactive government	Regionally Integrated
Lone Leopards	Proactive government	Fragmented Status Quo
Sleeping Lions	Reactive government	Fragmented Status Quo


Industrious Ants
Regional integration
Herd of Zebra
Proactive governance
Reactive governance
NEWS
ANOTHER NATIONAL SUCCESS
WATER CONFLICTS
NEWS
NGO SAVES THE DAY
uprising
Lone Leopards
Fragmented status quo
Sleeping Lions

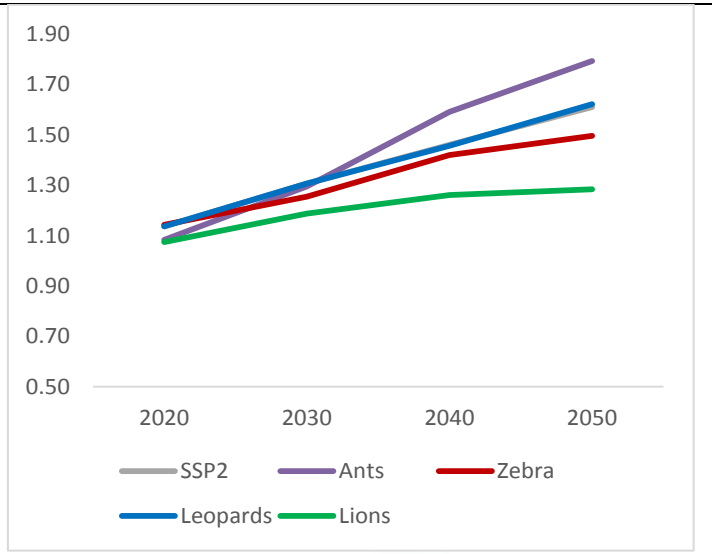

Socio-economic challenges for mitigation
Zebra
SSP 5:
(Mit. Challenges Dominate)
Conventional Development
Lions
SSP 3:
(High Challenges)
Fragmentation
Leopard
SSP 2:
Middle of the Road
SSP 1:
(Low Challenges)
Sustainability
SSP 4:
(Adapt. Challenges Dominate)
Inequality
Ants
Socio-economic challenges for adaptation

Quantitative Results: Crops yield in Eastern Africa

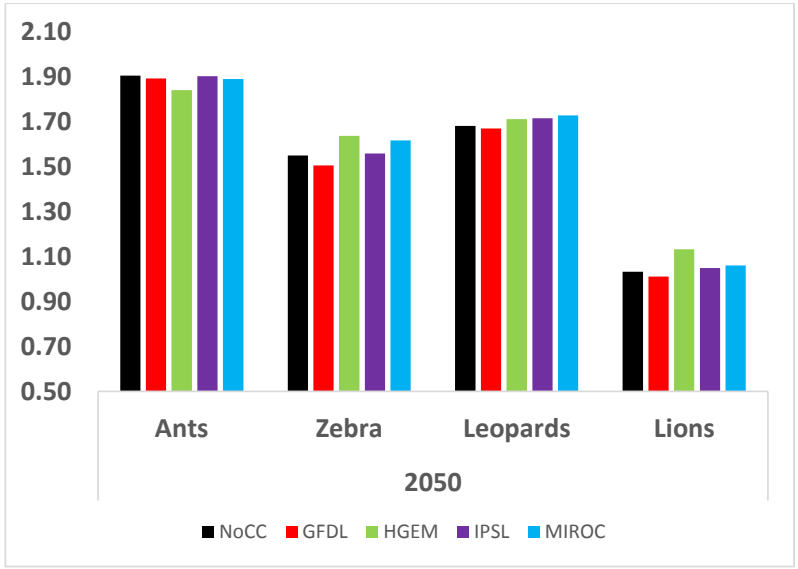
Crop Yields Trends (indexed to 2010)



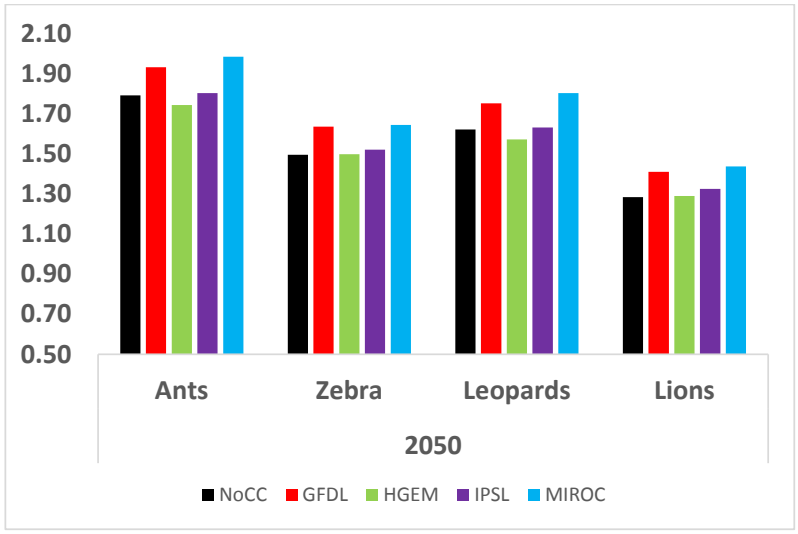
Maize



Cassava



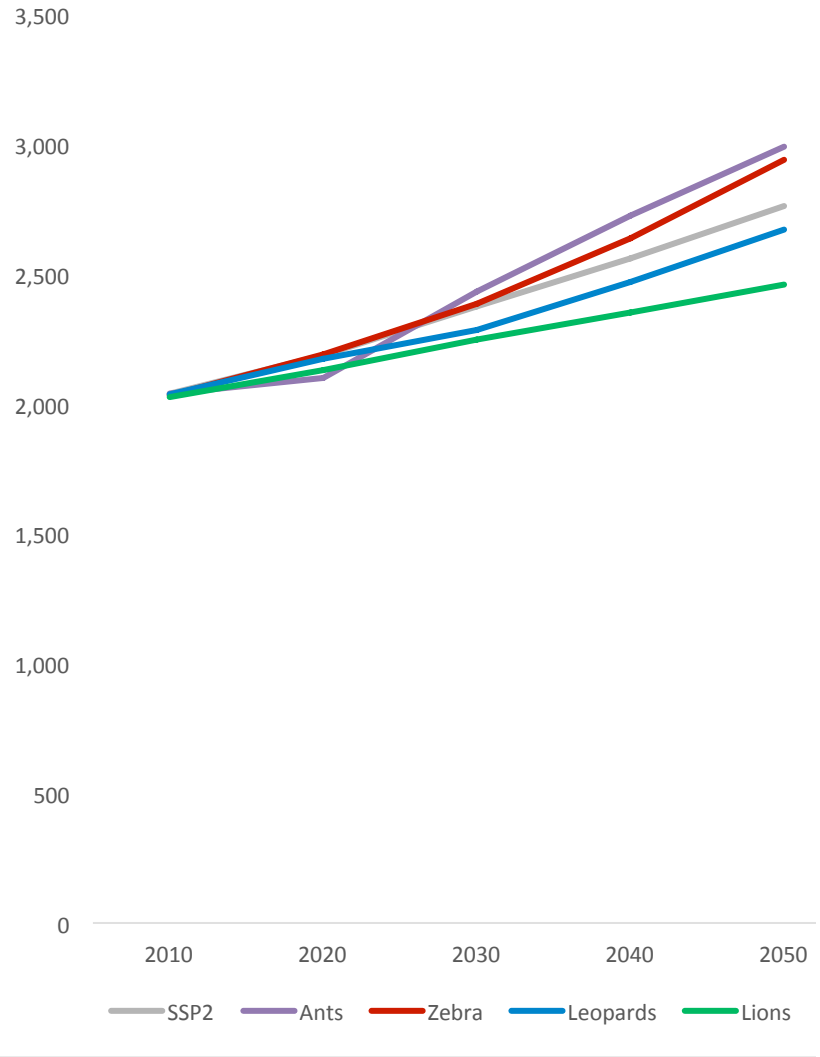
Maize

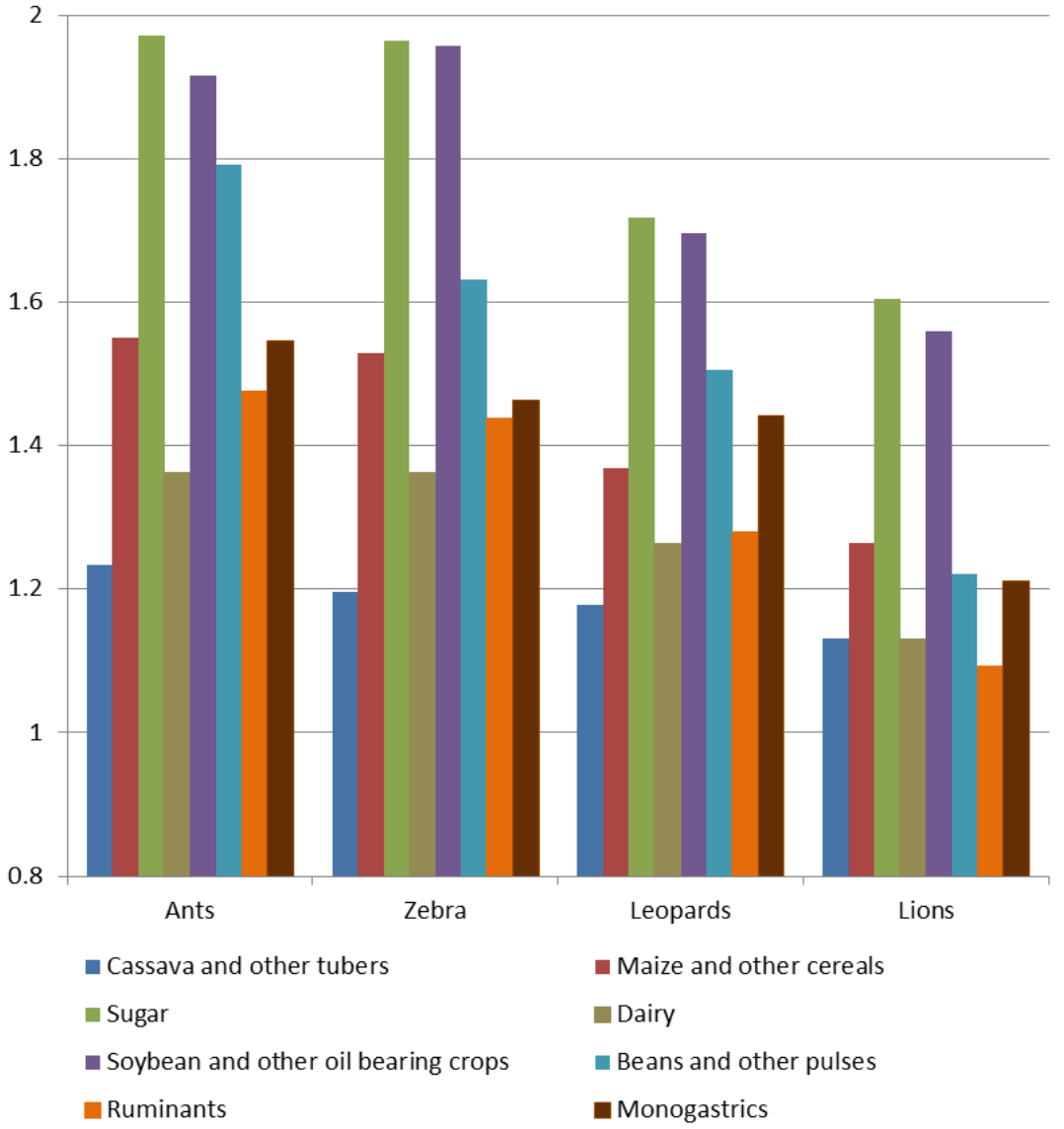


Cassava

Climate Change Effect on Crop Yields

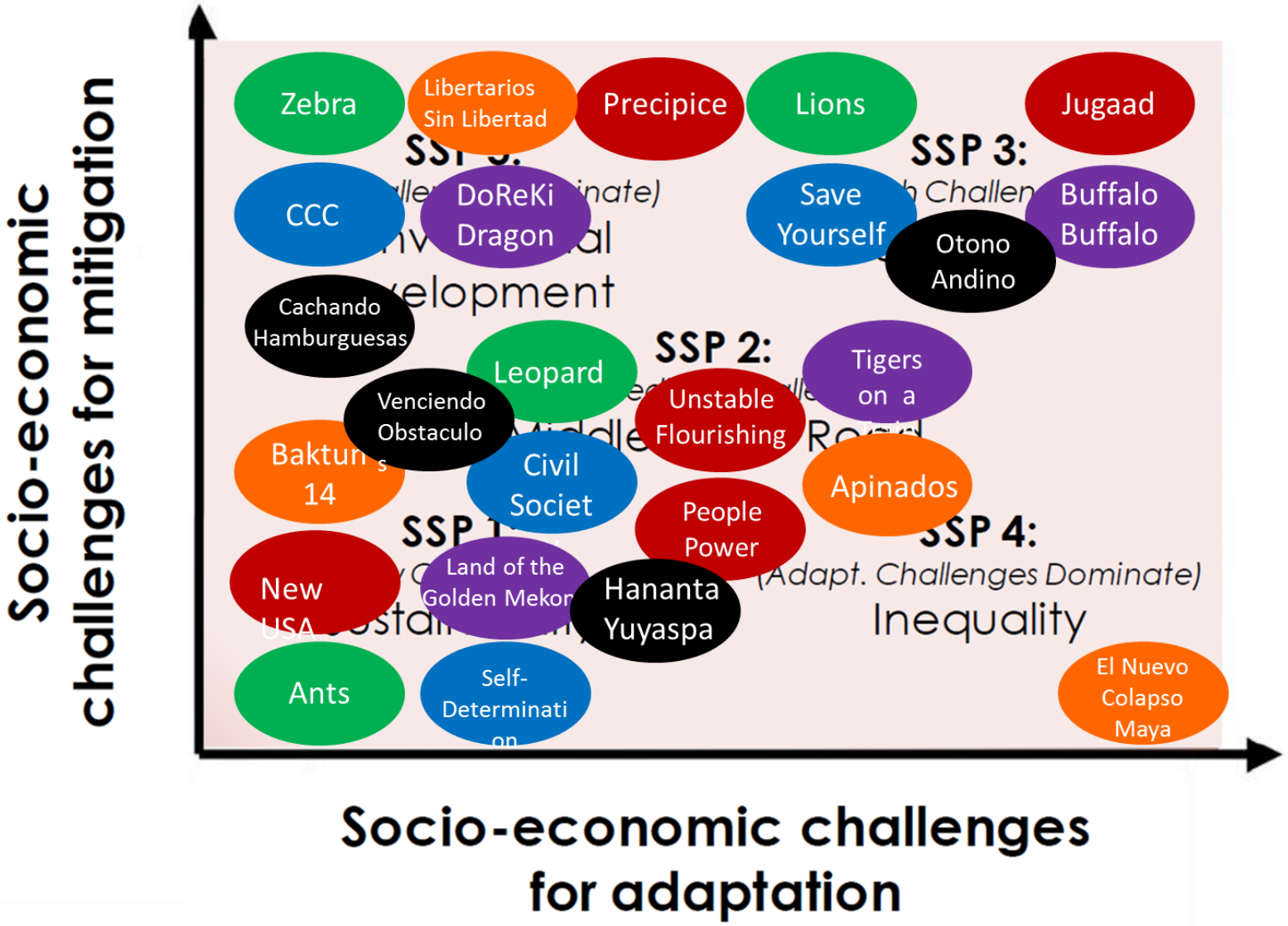
Quantitative Results: Food Security





Eastern Africa

Full set of regional scenarios in the SSP envelop



Scenarios in Policy Making

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Andean countries joi
the face of future sce

Also available in Español

Andean country representatives met to develop future socio-
November. Photo: E. van de Grift.
(view original)

*CCAFS Scenario team and p
governments in Bolivia, Col
Ecuador plan under uncert*

In the Andean countries, policy makers looking i
many changes – climate change, economic deve
competition for land use, and numerous other p

The CGIAR Research Program on Climate Chang
(CCAFS) Future Scenarios team has joined forces
Monitoring Centre (UNEP-WCMC) and University
(UCI) to help governments and their partners in
Ecuador plan under uncertainty.

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Helping Honduras build
adaptation strategy for

Also available in Español

CCAFS Scenarios team teamed up with the Honduran agriculture secr
strategy for the agriculture sector. Photo: N. Palmer (CIAT)
(view original)

*Future scenario development
approach helps further streng
risk management and climate
strategy.*

Honduras' agriculture sector, the backbone of the eco
vulnerable to climate variability and change. Bad weat
from increasing temperatures are already tormenting
and profits from the previously successful coffee and

This is however only one of many concerns facing the

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News Blog

Future scenario devel
Action Plan for Agricul

Developing scenarios that take into consideration multiple plaus
important for climate adaptation work. Cambodia recently decid
high-level climate policy work. Photo E van de Grift
(view original)

*The dedicated work by CCAF
pays off as future climate ar
scenario development and c
agriculture are now added t
policy landscape.*

*"Developing and using integrated socio-economic
models and Establishment of Carbon Accounting
and fisheries"*

Extract from the Cambodia's Climate Change

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What does the future hold for Bangladesh? Modeling scenarios for better climate policies

Bangladesh might get better prepared for climate change by taking climate impacts on agriculture and socio-economic aspects into consideration in policies and strategies,. Photo: M. Y. Tushar (WorldFish)
(view original)

Dec 11, 2014
by
Cecilia Schubert, CCAFS Communications Officer (CCAFS Flagship 4)

Tags
scenarios Data & Tools

Themes
Policies and Institutions

Regions
South Asia

Future Scenarios hit a high-level policy note in Bangladesh's Planning Commission as it considers using scenario development and modeling in 5 Year Government Plan.

Both the World Bank and the IPCC have declared Bangladesh as one of the most climate-vulnerable countries in the world in dire need of support and adaptation.

And as floods, tropical cyclones, storm surges and droughts start to become normal incidences for the country, the government is trying its best to prepare and protect its population.

But how does a country, with few

*DISASTERS
The number of people imperiled by storms and floods in Asia dwarfs all other regions of the world.

63

Posts by theme

Climate-Smart Agricultural Practices

Climate Risk Management

Low Emissions Agriculture

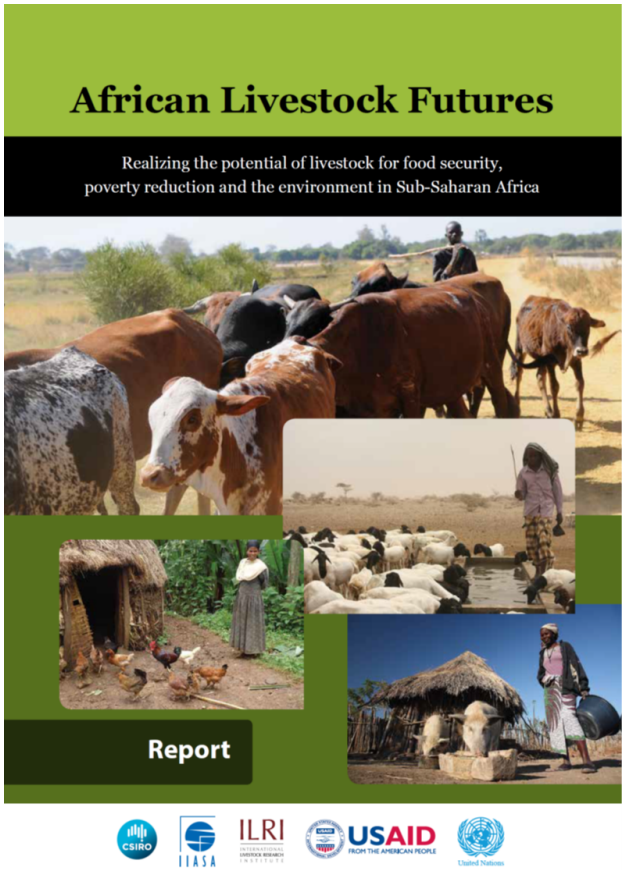
Gender and Equity

IIASA

Policy impact of regional scenarios

- Eastern Africa scenarios results used in two policy workshop in Feb 2015 to support
  - → **National Environment Management Policy (NEP) in Tanzania**
  - → **National Agriculture Policy and Mechanization Framework in Uganda**

- Application of SSPs to livestock role in sub-Saharan Africa produced for the UN



Conclusion

- Many components of RAPs are already present in SSPs
- 5 global economic models quantified a large number of the drivers with SSP markers applicable for RAPs
  - Data of SSP markers ready.
  - Adaptation and mitigation dimensions still to be added

- CCAFS scenario: 6 regions covered with extensive stakeholder consultation
  - Regional RAPs articulated around SSPs
  - Includes climate change impacts
  - 2 global economic models involved
  - How can this contribute to AgMIP regional scenarios?

- Much more detailed sub-continental assessments are possible using decidated versions of the models (lot of experience at IIASA)

Thank you…

For more information

www.globiom.org

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Amanda Palazzo palazzo@iiasa.ac.at

Already a first set of runs for EU models (AGCLIM50 project)

- AGCLIM50 projects with JRC: focus on RAPs for SSP1-SSP3 **+ adaptation scenarios**

Climate	SSP1	SSP2	SSP3	SSP4	SSP5
RCP8.5	X	X	X	X	**LOW SUSTAIN-ABILITY**
RCP6.0	RAP1	RAP2	RAP3	RAP4	
RCP4.5	**HIGH SUSTAIN-ABILITY**		RAP3m RCP3m+a		
RCP2.6	RAP1m RAP1m+a	RAP2m RAP2m+a	X	RAP4m	RAP5m
NoCC	RAP1noCC	**NO CLIMATE CHANGE**	RAP3noCC	RAP4noCC	RAP5noCC5

Intense biofuels
Heat resistant varieties
High protein demand
Food policy

Reference scenario
Mitigation scenarios
Mitigation + adaptation scenario
Pure SSPs

X – These combination are not feasible in current IAM runs, but may still be run in complementary scenarios

Already a first set of runs for EU models (AGCLIM50 project)

- AGCLIM50 projects with JRC: focus on RAPs for SSP1-SSP3 **+ adaptation scenarios**

Climate	SSP1	SSP2	SSP3	SSP4	SSP5
RCP8.5	X	X	X	X	**LOW SUSTAIN-ABILITY**
RCP6.0	RAP1	RAP2	RAP3	RAP4	
RCP4.5	**HIGH SUSTAIN-ABILITY**		RAP3m / RCP3m+a		
RCP2.6	RAP1m / RAP1m+a	RAP2m / RAP2m+a	X	RAP4m	RAP5m
NoCC	RAP1noCC	**NO CLIMATE CHANGE**	RAP3noCC	RAP4noCC	RAP5noCC5

High protein demand

Heat resistant varieties

Intense biofuels

Food policy

Reference scenario
Mitigation scenarios
Mitigation + adaptation scenario
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